

PALAEOWORKS TECHNICAL PAPERS 4

Simple bucket flotation and wet-sieving in the wet tropics

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Note

This information has been prepared for students and researchers interested in applying comprehensive archaeological recovery techniques in the tropics. It is open to use by everyone with the proviso that its use is cited in any publications, using the URL as the place of publication. Any comments regarding the information found here should be directed to the author at the above address.

Introduction

Flotation and wet-sieving are simple techniques for recovering plant remains, animal bones, shells, small artefacts etc from archaeological deposits. Many different methods and machines have been designed to facilitate flotation and wet-sieving (see Pearsall 2000 for the best review of the subject). The author has successfully used the following method in numerous archaeological projects across the world, including Papua New Guinea. I do not claim to have invented this method. It is an amalgam of ideas and techniques derived both from methods taught to me by a variety of people, such as Gordon Hillman, John Giorgi and Mark Nesbitt, and my own experimentation. The method is simple, requiring either equipment available in even the most remote locations or that which is light and easy to carry, but is very effective, even in the, sometimes difficult, conditions seen in the tropical regions. In fact, the close control over the flotation process that this method affords is perfectly suited to the many archaeological deposits found in the area containing plant remains that do not float! The example used to illustrate the method is that of excavations at Lachitu Cave and Taora Rockshelter, Fichin Village, Sandaun Province, Papua New Guinea, undertaken in May and June 2004. I end this introduction with a cautionary note: no single method is suitable for every site and soil the archaeologist encounters; experimentation, practice and persistence, with reference to key principles, are the keys to success. Bearing this in mind, this guide should be seen as a starting point for experimenting with suitable techniques for your site.

What are we trying to recover and why?

Flotation and wet-sieving are used together to recover the following from archaeological sediments:

- Small artefacts (beads, stone-working debitage, microliths etc)
- Animal bones, especially the small bones that are not easily visible to the naked eye
- Shells
- Plant remains (charcoal, seeds etc)
- Human remains, especially teeth and children's bones that are not easily visible to the naked eye

In theory all of these objects can be collected by hand during excavation, but in practice many are simply too small to be collected in this way without biasing the sample, especially plant remains and smaller animal bones, such as the fine bones of fish and small mammals.

Flotation and wet-sieving ensure that these small objects are systematically collected and that any bias in samples caused by selective collection procedures is minimised.

What is flotation?

Flotation in this context means using the natural buoyancy of charred (partially burnt) plant remains (though it can be used for waterlogged remains also) when mixed with water to separate them from sediments and allow easy recovery (usually by collection in a sieve).

What is wet-sieving?

Wet-sieving means sieving archaeological sediment in water to help remove unwanted sediment and leave artefacts and other objects in a sieve, from which they can be collected for study.

Basic principles

It is important to remember the following when processing archaeological sediment samples by flotation and wet-sieving:

- 1) Sieve size determines what is retained for analysis, so set the sieve size slightly smaller than the smallest objects you expect to find. Usually the flotation sieve contains mesh of 0.25mm in diameter and wet-sieving uses a 1mm diameter mesh.
- 2) The smaller the mesh the greater chance you have of blocking the sieves and the longer the flotation and wet-sieving will take
- 3) Flotation and wet-sieving produces at least two products: the floated fraction, hereafter “flot” and the wet-sieve residue, hereafter “heavy residue”. You need adequate drying space (trays, bags etc) and storage (bags) for these fractions and you also need to make sure that all fractions are adequately labelled. In addition, if the heavy residue is sorted in the field into different fractions, many bags of finds will be produced. Careful recording of these bags is recommended and correct labelling is essential.
- 4) Drying the flot and heavy residue is important, as wet material will grow fungus and, in the case of charred plant remains, makes them very fragile. As the tropics are very humid and prone to extended periods of rain, drying is not easily achieved and has to be planned carefully.
- 5) Take care not to mix the soil sample, flot and heavy residues of different samples. Mixing reduces or negates the usefulness of samples. This is an obvious thing to say, but it is easier than you may think to mix samples or their products together during processing.
- 6) This process is very labour intensive and can, if done carelessly, cause damage to back muscles. Take time in planning the location of your processing area to minimise the risk of back pain.

Equipment and other resources

The following equipment is required:

- 1) Basic flotation and wet-sieving
 - a) At least 30 large woven plastic sacks (rice or sugar sacks)#
 - b) A spring balance for taking weights*
 - c) At least 6 heavy-duty plastic/rubber buckets – light-plastic buckets will break quickly – at least one of which has volume marks (in litres on the inner surface)#
 - d) 1 narrow-diameter, light bucket with large holes cut in the bottom
 - e) 1 wide diameter mesh sieve ($\geq 2\text{mm}$) which fits in the bottom of the light bucket in b)*
 - f) At least 30 flotation bags (see Appendix 1) or a similar number of large squares (ca 60cm x 60cm) of chiffon (fine nylon mesh)* - note that I use chiffon because it does not absorb water, unlike muslin, so dries very easily.
 - g) Clothes pegs#
 - h) A string line on which to dry the bags
 - i) At least 2 large prospecting sieve with 1mm mesh base*
 - j) Lots of labels (see Appendix 3)*
 - k) At least 10 trays#
 - l) Lots of sealable plastic bags of various sizes (see Appendix 4)*
 - m) Permanent marker pens#
 - n) A log book and pencil; prepare several pages of the logbook as shown in Appendix 2, or print and take pro-forma record sheets* and a clipboard#
- 2) Dealing with the heavy residue
 - a) Items i) to n) above

- b) A balance capable of weighing to 100s of grams*
- c) 20cm or larger diameter brass test sieves with 4mm, 2mm and 1mm diameter mesh, lid and sample collector (base)*
- d) Forceps x 10*
- e) Small paint brushes x 10#
- f) 2 or more hand sweeping brushes#
- g) Table and niches/seats (these can usually be made quite easily using local materials)
- h) Heavy residue record sheets (see Appendix 5)

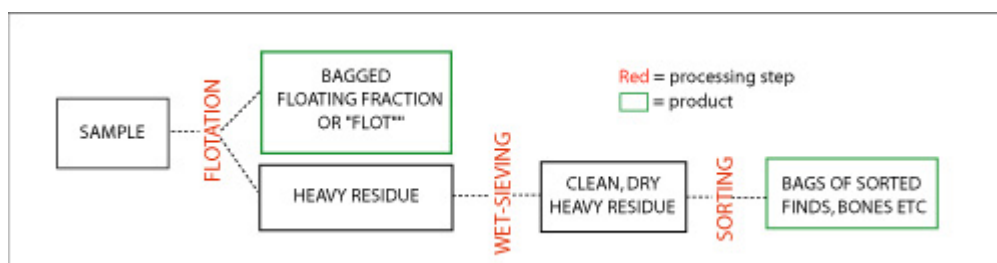
3) Other resources/installations required:

- a) A good supply of fresh water (stream, river etc). If you have no stream then you will need a water tank – the stream is much easier!
- b) A raised platform with a drain on which you can stand the flotation bucket and which allows the water you pour through it to drain away (a sago leaf base makes a perfect drain – see pictures)
- c) A dry area where you can stand and take breaks and on which you can lay out heavy residues

All of the equipment marked * normally has to be taken into the field; those marked # are available in many places, but may be harder to find in more remote areas.

A method

Flotation and wet-sieving are usually run as a single, three-step process, which has a sample of archaeological soil at the start and a series of bags of dried archaeological material at the end [Figure 1]. The flotation and wet-sieving are best run as a continuous process in one area, with the sorting done under cover at the dig house.



1. Flotation and wet-sieving

- a) Collect samples as you excavate using the robust plastic buckets and the woven plastic sacks [Figures 2 and 3]
- b) Give each new sample a sample number – write a list of sample numbers in the log book or on the flotation log sheet [Appendix 2]
- c) Weigh the soil sample in its sack and then pour it into the bucket with volume marks. Record both measurements in the logbook [Figure 4]
- d) At the flotation area, set up the drain, buckets and get the samples ready for processing [Figure 5]
- e) Place the wide diameter mesh sieve into the bucket with holes in the bottom and then lay a flotation bag [Appendix 1, Figure 18]/piece of chiffon into the bucket. Make sure that the bag/chiffon rests on the bottom of the bucket and use clothes pegs to secure it in place. This will form the flotation sieve [Figures 5 and 9]
- f) Write out two labels [Appendix 3], including the sample number assigned in b)
- g) Fill an empty bucket approx 1/3rd with soil [Figure 6]
- h) Add water until it is 9/10 full
- i) Stir gently with a stick or your hand to break up the soil and mix it with the water [Figure 7]
- j) Allow the water and soil to settle in the bucket for a few minutes
- k) Pour the water slowly through the flotation bag/chiffon in the flotation sieve [Figure 8]
- l) Stop pouring when sediment starts to flow into the flotation sieve
- m) Add more water and stir, repeat steps h to j
- n) You will see plant material (e.g. charcoal) floating into the sieve [Figure 9]; it often does not float very well and can be seen just above the sediment as you pour water into the flotation sieve. Continue with steps f to k until no more charcoal is visible
- o) Note that the flotation sieve often blocks and can overflow – see the note below about this issue and how to cope
- p) Pour out the heavy residue (non-floating material in the bottom of the bucket) into one of the large diameter prospecting sieve
- q) In a stream, river or your water tank, immerse the sieve and gently agitate to remove the sediment [Figure 10]
- r) When the artefacts, stones etc in the sieve are clean pour the heavy residue onto a dry, clean woven plastic sack, attach a label and put in the sun to dry; when dry, or at the end of the day, put the residue into the sack (or another if it is easier) with the label –

note, that because the woven sacks are porous the residue will continue to dry. It can also be poured out again at the base camp to dry in the sun the next day (Figure 11).

- s) Enter the sample details on the Heavy Residue sheet [Appendix 5]
- t) Take the rest of the soil sample and repeat steps g) to o) until all the soil from that sample has been processed
- u) Remove the flotation bag from the flotation sieve, add the label, tie it up and hang it from a drying line in the sun [Figure 11]. Normally I would not recommend drying directly in the sun, but in the tropics this is the only way to ensure that the sample actually dries and the high humidity may account for the limited damage caused
- v) Wash out the buckets thoroughly; start at e) and repeat for every sample
- w) When the flot and heavy residue are dry put them into a clean sealable plastic bag with the sample details written on the outside. Add another label [Appendix 3] to the inside of the bag. Store carefully in dry boxes, keeping a careful note of which box a bag is stored in. I recommend storing flots and heavy residue separately



Figure 2 Baiva Ivuyo collects soil for processing in excavations at Lachitu Cave (Photo Sue O'Connor)



Figure 3 Sample sacks (in foreground) being filled after weighing at Lachitu, Cave (Photo Sue O'Connor)



Figure 4 Andy Fairbairn recording on one of the many forms during excavation (Photo Sue O'Connor)



Figure 5 Basic flotation equipment: flotation sieve (upper right) on sago leaf drain, woven plastic sample sack (lower left) & plastic bucket (lower right)



Figure 6 Andy Fairbairn pours the sample into the bucket (Photo Andy Fairbairn)



Figure 7 Stirring up the sample after adding water (Photo Andy Fairbairn)



Figure 8 Pouring the water and floating plant material through the flotation sieve (Photo Andy Fairbairn)



Figure 9 The flotation sieve with a small amount of charred plant material from the lower levels of Taora (Photo Andy Fairbairn)



Figure 10 Ben wet-sieving in the river at Fichin village (Photo Andy Fairbairn)



Figure 11 Flotation sieves drying in the sun (Photo Andy Fairbairn)

2. Dealing with the heavy residue

- a) Dry the residue in the sun on a tarpaulin or sack as discussed above [Figure 12] – Note that you should secure each sample label to ensure that they don't blow away
- b) Weigh the dried residue
- c) Take the dried residue for a sample and pour it through the stack of brass sieves. Shake so the sample is split into different size fractions. Leave to settle. Note that sieving in this way speeds up sorting.
- d) If you don't have the sieves you can do the following with small batches of the whole sample
- e) Spread out each sample fraction on a tray and using hands, forceps or brush (whichever you prefer) pick out the following classes of materials, making separate piles on your tray of each [Figures 13 and 14]:
 - a. Shell
 - b. Fish bone
 - c. Non-fish animal bone (mammal, bird etc)
 - d. Flaked stone
 - e. Beads
 - f. Worked shell
 - g. Pottery
 - h. Plant material (charcoal and seeds)
 - i. Anything else that you want to collect and keep
 - j. A discard heap of large stones, coral etc (Figure 13, upper left)
- f) When the fraction is sorted, weigh the material to be discarded and record [Appendix 5]; then bag up the sorted material in separate bags, label appropriately with site, unit/spit, sample number, size fraction (if fractionated) and material; now seal the bags.
- g) Check off what has been recovered from each sample on the heavy residue record sheet (Appendix 5)
- h) Now either: a) place all of the bags from one sample within a larger bag and label it accordingly OR b) place in bags by material type (i.e. one bag contains all fish bone, another beads etc) [Figure 15]
- i) Repeat for each size fraction or sub-sample
- j) Store the residue in boxes after carefully inventorying what each contains [Appendix 6]

A note on scheduling tasks, labour input and time requirements

All of the above can be done by a single person but it really helps to have one or two flotation assistants [Figure 16] and several people working on the heavy residue. This allows the processes to be run in parallel. In Fichin Village, Vanimo 2004, I ran the flotation and handed the residue to one of the two Ben's for wet-sieving. The other Ben, whoever was not sieving, was charged with filling buckets with water from the stream, checking and weighing sample sacks, labelling etc. This parallel processing greatly increases the speed of work. In this case, 100% of soil was processed from the small excavation trench (a total of >3,000 kg of soil). I estimate that it took our team of 3 one full day to fully process the soil produced by one day of excavation, that is approx 300 kg of soil (ca 350 litres). Processing and sorting of the heavy residue took much longer. 7 sorters took approximately 18 days to sort the larger fractions of all samples and approx 20% of the smaller size fractions (<2mm). Actual processing speed depends on experience and morale.



Figure 12 Sorting and drying heavy residues (Photo Andy Fairbairn)



Figure 13 Sorting heavy residues (Photo Sue O'Connor)



Figure 14 A partially sorted heavy residue with shells, bones and discard in piles (Photo Sue O'Connor)



Figure 15 Fully processed samples lined up before preparing inventory and packing them for shipment (Photo Andy Fairbairn)



Figure 16 Andy with Ben and Ben at the processing area (Photo Andy Fairbairn)



Figure 17 A sudden rainstorm (Photo Andy Fairbairn)

A note on sampling

Sampling is a difficult and much-discussed issue. The simple question of “what is the correct sample size for a site” is not easy to answer. For the 1m x 1m test pits excavated in Papua New Guinea I have floated and wet-sieved all of the soil. For larger excavations this is not possible, without using a flotation machine. At a minimum I would suggest processing at least 60 litres of soil (6 buckets) from each excavated context on a site (or all of it if contexts are smaller). Where sites are large and complex it may be worth focusing sampling and processing on secure contexts, for which the formation history is understandable, for example rubbish dumps, hearths, house destruction levels etc. Where 100% sampling is not possible, the decision of what to sample and how much ultimately depends on the overall archaeological objectives of the project and the resources available to the site/sample processing team. I would encourage all excavations to collect and process at least some soil samples by this method as it really is the only way to recover small items, especially plant remains, but the scale of sampling is up to the judgement of the excavation team.

Some other observations

- a) Sieve blockages – The flotation sieve will regularly block as sediment flows into it. Be careful as if the sieve overflows you will lose the charred plant remains. Blockages can usually be cleared by carefully pouring clean water through the sieve and by gently tapping the base mesh of the sieve.
- b) Speed of flotation – Flotation can be a long and tiring job, especially when sediments are fine-grained and samples rich. Take your time. Rushing the job reduces its efficiency and the effectiveness of the process.
- c) Hands – flotation and wet-sieving can be very harsh on bare hands. I prefer to use my hands to mix the sample with water and this can cause cracking of the skin. Take some hand cream with you to help relieve this problem or use thin plastic gloves
- d) Chiffon cutting – if you want to use chiffon squares, rather than flotation bags, prepare the squares at the excavation site from a roll of chiffon taken to the field. This ensures that the squares fit the flotation sieve, which varies in size with the availability of buckets.
- e) Take more supplies than you think you need – it is almost impossible to estimate precisely how many sacks, bags and marker pens you need. Overestimate, especially if such vital equipment as woven plastic sacks are unavailable in your excavation area – as in many parts of Papua New Guinea. Plastic sacks are actually useful for all excavation needs and I recommend taking lots.
- f) Use of streams and rivers – In many places streams and rivers are the main source of drinking and washing water for communities. Make sure that permission and advice is sought before using streams and rivers for wet-sieving. Pollution of a watercourse with sediment is guaranteed when processing soil samples and can cause health problems, disquiet and even imperil archaeological missions if done without due thought.
- g) Drying samples – drying flots and heavy residue reduces their weight and reduces damage to delicate components, but is difficult in the humid tropics and has to be carefully planned. Put samples under cover at night and keep watch for rain, as several days of good drying can be erased in a few minutes of rainfall [Figure 17]. Having two drying lines and residue drying areas – one each under cover and one each in full sun – makes life much easier
- h) Record mishaps – While everyone tries to minimise errors, it is impossible to run a processing operation without making some

- i) Record sheets – these can be drawn up in the field, but it's better to take some pro forma with you. The best are printed on "rite in the rain" paper and don't disintegrate when it rains – this is very handy in the tropics where paper forms can disintegrate easily.
- j) Preparing samples for shipping is time-consuming and causes more work back at the laboratory if it is done badly. I suggest compiling a detailed inventory of the number of bags and boxes of each type of material in each shipping carton (by this I mean thick box) at the time of packing. It adds a little time to the time you spend packing, but really is worth it as it saves time locating samples back at the laboratory, especially if the site is large. In some countries the authorities demand a detailed inventory of everything to be exported, so the compilation of an inventory is necessary anyway.

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Appendix 1 – making flotation bags

I take no credit for this flotation bag design. It originally came from Mark Nesbitt and was taught to me by Amanda Kennedy.

Requirements for 1 bag [Figure 18]:

1x 28cm x 28cm piece of 250 μ m (0.25mm) grade scientific mesh (**a** in Figures 1 and 2)

1x 45cm x 100cm piece of chiffon (nylon, very fine netting – **b** in Figures 1 and 2)

1x 130cm length of cord (**c** in Figure 18, boxes 1 and 2)

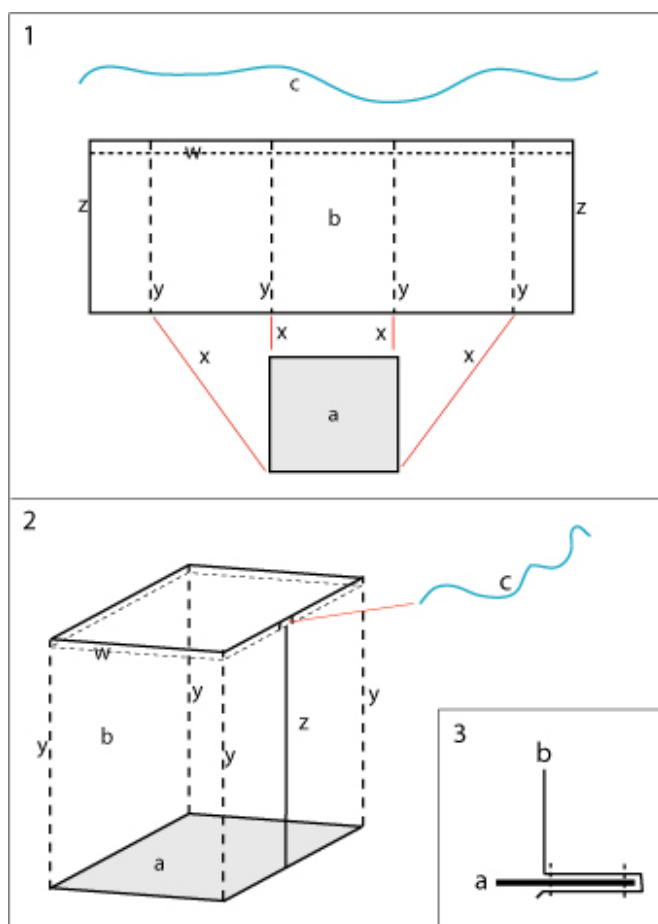


Figure 18. A pattern for making a flotation bag

The square of scientific mesh **a** forms the base of the flotation bag. One of the long edges of the chiffon **b** is sewn around the edge of the base mesh. In Figures 1 and 2 the folds **y** in the chiffon correspond to the corners of **a** and **x** shows the attachment points. The seam between **a** and **b** should overlap (Figure 18, box 3) and double sewn (dashed lines in Figure 3), with the seam positioned on the outside of the bag (to the right of Figure 18, box 3), reducing the places in which plant material can become caught. The two short edges of the chiffon **z** are then sewn together, again with an overlapping seam. The free edge of the chiffon is folded along line **w** and sewn to form a 2cm pocket along the edge of the bag. The end of this pocket should be left open and the cord **c** can then be threaded into it (Figure 18, box 2). The drawstring allows closure of the bag and can also be used to hang it up to dry.

Note that it is important to use synthetic material in the bags as cotton etc absorbs water and takes longer to dry.

Appendix 2 – preparing the flotation logbook

I use the a sample logbook formatted as follows or pro-forma printed before I go into the field on “rite in the rain” paper:

Site	Sample No.	Unit/Spit	Weight (kg)	Volume (l)	Date Collected	Date Processed	Unit Description	Notes

The sample number is given by the flotation operator; the Unit/Spit entry refers to the archaeological context/provenance; the unit description can be useful during the early stages of analysis when selecting samples to prioritise; Notes is included to record details such as spills and samples with lots of material, or any other relevant information.

A PRINTABLE SHEET CAN BE FOUND AT THE END OF THIS DOCUMENT

Appendix 3 – labels and labelling

I recommend using labels made from Tyvek, a hardwearing plastic material that accepts writing with permanent markers very well, is almost impossible to rip (it has to be cut) and does not disintegrate in the rain. The department’s Tyvek labels are printed by a commercial company and are shown in Figure 19 [Figure 19]. They are 6.5 cm x 8.5 cm, but size can be varied to needs.

Labelling is important for this process as several products are produced from each sample and it is easy to mix them up. Ideally, one label should be written for each sample flot or heavy residue. This should be included in the sample bag and the sample details should also be added in pen to the outside of the bag. Double labelling acts as security against losing sample details.

SITE:	
LAYER/UNIT:	
CONTENTS:	
DATE:	INITIALS:

Figure 19. Label, as used in ANH

Appendix 4 – plastic bags

We have found the 22 cm x 15 cm sealable plastic bags useful for storing flots and the 39 cm x 25 cm sealable plastic bags (thick plastic) useful for storing heavy residues, while smaller bags (8 cm x 5cm, 12 cm x 7cm etc) are good for storing smaller heavy residue contents.

Appendix 5 – Heavy residue record sheets

Using heavy residue record sheets is a really handy way of keeping track of what you've found. This is an example:

Site:		Date excavated:		Context description/Notes:							
Unit/Spit:		Date sieved:									
Sample No.:		Date sorted:									
Total weight:		Residue description:									
	Sorted	Packed	4 mm fraction		2 mm fraction		1 mm fraction		Total		
			Weight	Count	Weight	Count	Weight	Count	Weight	Count	
ARTEFACTS ETC											
Pottery											
Flaked stone											
Polished stone											
Worked shell											
Worked bone											
Ochre											
Beads											
Other (specify)											
Other (specify)											
BIOLOGICAL REMAINS											
Shell											
Fish bone											
Non-fish bone											
Sea urchin spines											
Charcoal											
Seeds											
Other (specify)											
Other (specify)											

All of the basic sample and processing information is recorded in the upper box. The central box records the overall characteristics of the residue and the lower box the details of what is found. I have split the contents into two groups: artefacts and biological remains and left space for types of material not included on the sheet (other). The “sorted” and “packed” columns are ticked when those processing stages are complete, while the columns to the right allow quantification of the sample contents in either field or laboratory.

A PRINTABLE SHEET CAN BE FOUND AT THE END OF THIS DOCUMENT

Appendix 6 – Sample inventory sheets

I suggest using a pro-forma sheet, again printed on “rite in the rain” paper, to record where samples are stored for shipping. This is form is based on our needs in Vanimo 2004:

Carton/crate no.	Box No.	Description of contents (number of bags, contents etc)

In this case the sample bags were packed inside small boxes, which were then packed inside large, thick-walled cardboard cartons for shipping to Australia. The sheet follows that storage structure, with the large description column providing space for writing the type of material and number of bags. When time allows you could fill in the exact box contents on several lines per box (e.g. Bags of shell from spits 1, 2, 4, 5, 6 and 8) or, if time is short, simply the number of bags of what kind of material (e.g. 6 bags of shell). A downloadable example can

be found here which has space for recording the site, date of packing and date of shipping, all of which may be important later if things go missing!

A PRINTABLE SHEET CAN BE FOUND AT THE END OF THIS DOCUMENT

Reference

Pearsall, D. 2000. *Paleoethnobotany, a handbook of procedures*. San Diego Academic Press.

FLOTATION LOG

[illegible]

HEAVY RESIDUE SHEET

[illegible]

SAMPLE INVENTORY FOR SITE: ☐ ☐ ☐

DATE PACKED:

DATE DISPATCHED:

[illegible]